**SCH3U – Solutions and Solubility Concept Presentation Summary** Holly Grandy

**Concept** : Solutions and their characteristics.

**Expectations**

E2.1 - use appropriate terminology related to aqueous solutions and solubility

E2.4 – conduct an investigation to analyse qualitative and quantitative properties of solutions

E3.2 – explain the process of formation for solutions that are produced by dissolving ionic and molecular

compounds

E3.3 - Explain the effects of changes in temperature and pressure on the solubility of solids, liquids and

gases.

**Background Information**

Solutions are homogeneous mixtures as they only have one phase. A heterogeneous mixture has two or more phases. All liquid and gaseous mixtures that are translucent or opaque are heterogeneous mixtures e.g. oil and water, blood.

A solution is a homogeneous mixture of a solute (the substance that is in the lesser quantity) in a solvent (the substance that is in the greater quantity). A solution may contain more than one solute.

A solution of two or more metals is called an alloy. Solutes and solvents can be liquid, solid or gas. Examples of solutions include air, pop, humidity, clear apple juice, brass, urine and gasoline. Aqueous solutions contain water as the solvent, are transparent and can be clear or colourless.

Dissolving – Ionic compounds dissociate as they dissolve, releasing their ions into solution. Molecular compounds vary in how easily they dissolve in water. Liquids that mix with each other are miscible. Liquids that do not mix are immiscible. A solubility table shows which metal compounds are soluble and which are not.

**Advance Preparation**

The solutions and solubility unit usually follows the stoichiometry unit. Students should be introduced to the qualitative properties of solutions before quantitative solution chemistry is studied. Students would benefit from a basic understanding of the mole and of matter and bonding. A review of Lewis structures and intermolecular forces may be needed.

**Special Materials & Equipment**

Teacher Demo - 2L clear pop bottle, vegetable oil, food coloring, alka seltzer tablets

Student Lab - test tubes, test tube holders, Bunsen burners, stirring rods, 10 mL graduated cylinders, sugar, iodine, alcohol, distilled water, sodium chloride, sodium sulfate, lead nitrate solution, potassium iodide solution, sodium acetate tri hydrate

**Student Difficulties**

* Understanding the distinction between the terms clear and colourless. Show copper II sulfate solution and sodium chloride solution. Ask which solution is colourless (sodium chloride) and which solution is clear (both). Point out a solution should always be clear because it is transparent, but it can be coloured or colourless.
* Thinking that increasing the temperature of a solution increases the solubility of gas solutes but in fact, it decreases. The secret to keeping pop fizzy is to keep it cold. The higher the temperature, the less the carbon dioxide molecules will dissolve.
* Reading and understanding solubility tables; use a mnemonic “CHOPS NAAA” : CHOPS

(carbonates, hydroxides, oxides, phosphates and sulphides are mostly insoluble); NAAA (nitrates, acetates, alkali metals, ammonium are mostly soluble; have students create a VIP to remember rules and steps

* Determining whether a solvent/solute is polar or nonpolar; review intermolecular forces, draw Lewis structures of the solvents, make molecular models of solutes or conduct polar and nonpolar solvents lab listed below

**Safety Considerations –** safety goggles, aprons, proper disposal of solvents (not down the sink!),

review location of eyewash station, fire extinguisher, tie back long hair,

and ensure there is no loose clothing for Jigsaw lab activity

**Teaching Ideas –** Think Pair Share, Concept Attainment, Jigsaw Lab Activity, Co-operative

Learning Groups

**Assessment & Evaluation Procedures**

Concept Attainment Activity (whole group) - Assessment for Learning: K/U

Teacher observes students during lab and asks guiding questions - Assessment for Learning: C

Mind Map (small group) - Assessment for Learning: A

Homework - How does lava lamp work? - Assessment for Learning: T/I

**Practical Applications and Societal Implications**

- changes in temperature or atmospheric pressure affect the solubility of oxygen in lake water

– contents/effects of traditional cleaning solvents vs. “green”/homemade cleaning solvent

- water treatment (purification and waste water); reducing individual “water footprint

- reactions in the human body all occur in solution; IV solutions consist of glucose and water

- alloys such as steel, brass and bronze are have industrial and commercial applications

**Lesson Sequence** – please refer to Lesson sequence Chart

**Related Student Labs** – please refer Lesson Sequence Chart

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| **Lesson & Expectation** | **Lesson Outline** |
| **Lesson 1**  E1  E1.1 | **Water**  Pressures on the Water Supply  <http://www.youtube.com/watch?v=HW5eBfZhE4M> (importance of water)  <http://www.youtube.com/watch?v=_R_vpNQ0fJc&NR=1> (drinking water availability)  Activity - predict water footprint of various products (i.e. # L of water to produce an apple, a hamburger, 1kg cheese etc.); predict national water footprints and compare to global average (which country has the smallest water footprint? Largest? Where does Canada fit in? Check out the interactive map!)  Computer lab – Estimate then calculate your water footprint. Estimate the school’s water footprint. What can you do to reduce these footprints?  <http://www.waterfootprint.org/?page=files/home>  **Four Corners Activity** – global water crisis re: population growth, increasing demand, pollution of water sources (Assessment as Learning: C)  <http://www.edu.gov.on.ca/eng/studentsuccess/thinkliteracy/files/Oral.pdf>  \*assign students to Jigsaw Groups and hand out lab to preview for next class |
| **Lesson 2**  **\*Power point**  E2.1  E2.4  E3.2  E3.3 | **Introduction to Solutions -** The Soluble Song <http://www.rathergood.com/soluble>  **Think-Pair-Share** – list examples of soluble & insoluble substances and solutions  **Concept Attainment** –teacher sorts 3-4 mixtures into groups (don’t name groups!)students sort the rest and justify their choices: sand in water(HM), smoke (HM), blood (HM), chicken soup (HM), vinegar in oil (HM), concrete (HM), soil (HM), gasoline (S), pop (S), humidity (S), clear apple juice (S), brass (S), silver-coloured dental fillings (S), air freshener (S), chlorinated pool water (S), a jar of jelly beans (HM), latex paint (HM), compressed air in a scuba tank (S), chlorine bleach (S), pure liquid honey (S), 24 karat gold (S). Answers: solutions (S), heterogeneous mixtures (HM) (Assessment for Learning: K/U)  **Demo –** lava lamp in a bottle (can be premade to save time) ask students to think about what happened; lab stations will help them to figure it out  <http://www.youtube.com/watch?v=WayviQkusxI&feature=related>  <http://www.sciencebob.com/experiments/lavalamp.php>  **Lab Safety Review**  **Lab Stations** - Jigsaw Activity (Expert Groups) \*2 of each station   1. Investigate the solubility of some substances in water and alcohol.   Why do some of the solutes dissolve in certain solvents?   1. Investigate the effect of temperature on the solubility of a solid.   How does temperature affect the solubility of a solid?   1. Prepare a supersaturated solution.   Describe the reaction of supersaturated solution and give information about the heat.   1. Investigate the formation of a precipitate.   Write the balanced equation for the precipitation of lead (II) iodide, PbI2.  <http://www.siraze.net/chemistry/sezennur/subjects/experiment/017.pdf>  Teacher observes students and asks guiding questions (Assessment for Learning – C)  **Mind Map of vocabulary** (Home Groups): solubility, solution, heterogeneous, homogeneous, solute, solvent, saturated, unsaturated, supersaturated, aqueous solution, precipitate, temperature; (Assessment for Learning – A)  **Homework**: How does lava lamp work (one paragraph)? (Assessment for Learning – T/I) |
| **Lesson 3**  E2.1  E3.1  E3.2 | **Dissolving Process**  **Think-Pair-Share** - recall unique properties of water (e.g. high melting & boiling points, expands when cooled, high surface tension, inability to mix with non-polar compounds, known as the universal solvent); show video on the properties of water & hydrogen bonding <http://www.schooltube.com/video/b36a222fcdfef2db9af8/Properties-Of-Water>  **Quiz** – The Properties of Water (Assessment as Learning: K/U) <http://www.visionlearning.com/library/quiz_taker.php?qid=20&mid=57&mcid>  **Dissolving of Ionic Compounds Demo –** havestudents predict results first!  <http://www.saskschools.ca/curr_content/chem30_05/4_solutions/teacher/solutions_teacher_lab.htm#conductivity>  OR you can show this video <http://www.youtube.com/watch?v=aELPrWzixeU&NR=1>  Dissociation of salt video <http://www.youtube.com/watch?v=EBfGcTAJF4o>  **Dissolving of Molecular Compounds -** Role play dissolving process – students act out the dissolving of different solutes in water (polar solvent) and oil (non-polar solvent)  (Assessment as Learning: K/U, C)  **Lab** - Polar and Nonpolar Solvents Lab to show concept of “Like dissolves like”  <http://dwb.unl.edu/chemistry/microscale/MScale26.html> |
| **Lesson 4**  E2.1  E2.4  E3.4 | **Solubility and Saturation**  Lab - Supersaturated Solutions  <http://atlantis.coe.uh.edu/texasipc/units/solution/solutions.pdf>  <http://www.youtube.com/watch?v=xTIzMaSDZ3k> (demo)  sodium acetate + seed crystal creates a stalagmite (demo)  <http://www.chem.wisc.edu/deptfiles/genchem/demonstrations/Gen_Chem_Pages/11solutionspage/solutionsmain.htm>  The Solubility Table and Chemical Reactions - review by playing team game (Jeopardy)  (Assessment for Learning: K/U, A) |
| **Lesson 5**  E3.2 | Lab - Solubility and Temperature <http://galileo.phys.virginia.edu/education/outreach/8thgradesol/TempSolubilityST.htm>  (Assessment for Learning: T/I)  Explanation of solubility and temperature relationship  <http://www.elmhurst.edu/~chm/vchembook/174temppres.html>  Song to summarize content: <http://www.youtube.com/watch?v=VTmfQUNLlMY> (funny!)  Factors affecting solubility <http://www.youtube.com/watch?v=4cr9w23GcTs>  Practice Questions & Answers on solubility curves <http://www.saskschools.ca/curr_content/chem30_05/4_solutions/practice/q3_2.htm> |
| **Lesson 6**  E2  E3  E2.4  E3.4 | **Culminating Task** (Assessment of Learning: K/U, T/I, A)  Solubility Rules and the Mystery Solutions Task  <http://dwb.unl.edu/chemistry/microscale/MScale26.html> |

**Annotated References**

Chemistry 11, Haberer, S. et al. Nelson Education Ltd., Toronto : 2010.

Ministry accepted text that matches curriculum expectations.

Boulware, B J. (2008). [Using the Concept Attainment Strategy to Enhance Reading Comprehension](http://simplelink.library.utoronto.ca/url.cfm/111075). The Reading Teacher, 61(6), 491-495. This article discusses a teaching method to introduce new concepts.

Brooks, J G. (1990). [Teachers and Students: Constructivist Forging New Connections.](http://simplelink.library.utoronto.ca/url.cfm/110872) Educational Leadership, 47(5), 68-71. This article discusses the Exploration-Invention-Discovery approach to learning.

**Annotated Internet Addresses**

<http://dwb4.unl.edu/chem_source_pdf/PPTN.pdf>

Davis, R., Owens, P. and Summerlin, L. (1994). Solubility and Precipitation (PPTN): A Source Book Module. ChemSource, 1-29. ChemSource has a related site called Sourcebook which provides comprehensive downloadable user-friendly modules on key senior chemistry concepts including stoichiometry, the mole, chemical bonding and rates of reaction.

<http://www.saskschools.ca/curr_content/chem30_05/4_solutions/teacher/solutions_teacher_index.htm> This website provides lesson plans and student activities for chemistry topics.

[http://dne.ode.state.oh.us/ims.itemdetails/lessondetail.aspx?id=0907f84c805309ab t01](http://dnet01.ode.state.oh.us/ims.itemdetails/lessondetail.aspx?id=0907f84c805309ab)

The Ohio Department of Education website has a wide selection of downloadable lesson plans and culminating tasks sorted by subject area and grade. Source of Solubility Rules and the Mystery Solutions Culminating Task.

<http://www.dbooth.net/mhs/ap/index.html>

Mr. Zahm’s website for high school chemistry with lots of funny and useful links

<http://www.google.ca/search?sourceid=navclient&aq=1&oq=solubility+curve+lab&ie=UTF-8&rlz=1T4ADSA_enCA439CA439&q=solubility+curve+lab+answers>

A comprehensive lab involving data gathering and creation of a solubility curve from the University of Manitoba Outreach program.

<http://www.siraze.net/chemistry/sezennur/experiments.htm>

This site has a variety of chemistry experiments with easy to follow instructions for students; source of Jigsaw Lab Activity.

<http://dwb.unl.edu/chemistry/microscale/MScale26.html>

David W. Brooks Research Site aimed at chemistry teachers; source of polar vs. nonpolar solvents lab.

<http://www.sciencebob.com/experiments/lavalamp.php>

The Science Bob site has a variety of demos, experiments and explanations of concepts.